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A Search for EHB Pulsators in the Globular Cluster NGC 6752

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Abstract. We describe the status of a project whose main goal is to detect variability along the extreme horizontal branch of the globular cluster NGC 6752. Based on Magellan 6.5m data, preliminary light curves are presented for some candidate variables. By combining our time-series data, we also produce a deep CMD of unprecedented quality for the cluster which reveals a remarkable lack of main sequence binaries, possibly pointing to a low primordial binary fraction.

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1. Introduction

Among field B-type subdwarf (sdB) stars, three types of non-radial pulsators have so far been detected, namely:

- EC 14026 (sdBV) stars: these are p-mode pulsators whose temperatures fall in the range between 29,000 and 36,000 K. Their periods are typically found in the range 100-200 sec, and their amplitudes cover the range from 0.4 to 25%.

- PG1716+426 ("Betsy") stars: these are g-mode pulsators, with temperatures in the range between 25,000 and 30,000 K. Their periods are much longer, typically falling in the range between 2000 and 9000 sec, and their amplitudes are smaller than 0.5%.

- Hybrid stars: these are stars that present simultaneous p- and g- mode oscillations. At present, only two examples have been reported in the literature (Baran et al. 2005; Oreiro et al. 2005; Schuh et al. 2006).

Performing asteroseismology on these stars holds the promise to unveil their innermost secrets, thus providing an exciting new route toward the solution of the so-called "second-parameter problem" (Catelan 2005, and references therein). The great promise of the technique notwithstanding, such variables have never been detected in previous searches in globular clusters (e.g., Reed, Kilkenny, & Terndrup 2006).

Accordingly, the main purpose of the present study is to perform a new search for this type of variables in the relatively nearby southern globular cluster NGC 6752, which contains a very long blue HB "tail," and thus many potential candidates for the three aforementioned variability types.

2. Observational Data

Our study is based on data acquired with the Magellan II (Clay) 6.5m telescope (259 V- plus 36 B-band images), taken in May 2006 at Las Campanas Observatory, Chile, using the MagIC high-resolution camera; and also on data acquired with the Magellan I (Baade) 6.5m telescope (829 V- plus 2 B-band images, taken in July 2007, using the IMACS mosaic camera in f/4 mode). While the MagIC images cover only two small fields of 2.4×2.4 arcmin size, the IMACS images, taken in subraster mode, cover a much larger field, of size 15.4×7.7 arcmin. Neither of these cameras is particularly suitable for rapid photometry. However, with a readout and exposure times both as short as 20 sec in the case of MagIC ($\sim$ 50 sec in the case of IMACS f/4 in subraster mode), there is a real chance to detect, for the first time, non-radial pulsators along the EHB of a globular cluster. Our ongoing search for variable stars using these datasets is based on both absolute photometry (using ALLFRAME/TRIAL; Stetson 1994) and difference imaging (ISIS v2.2; Alard 2000).

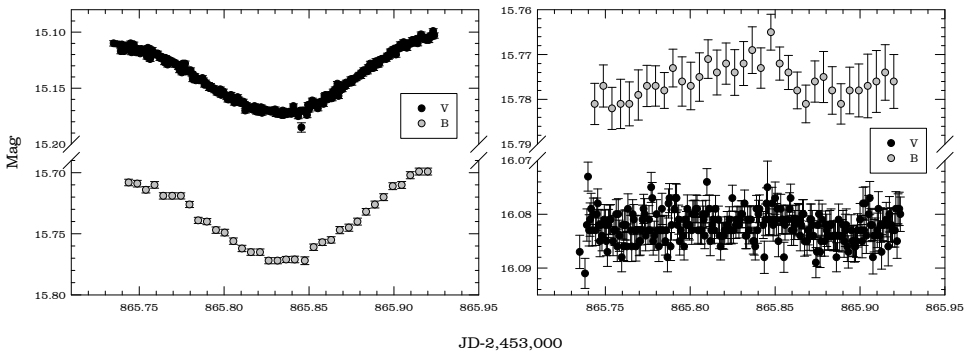

Figure 1. Light curves for two variable star candidates in our studied MagIC fields. *Left:* an eclipsing binary. *Right:* a candidate variable on the blue HB.

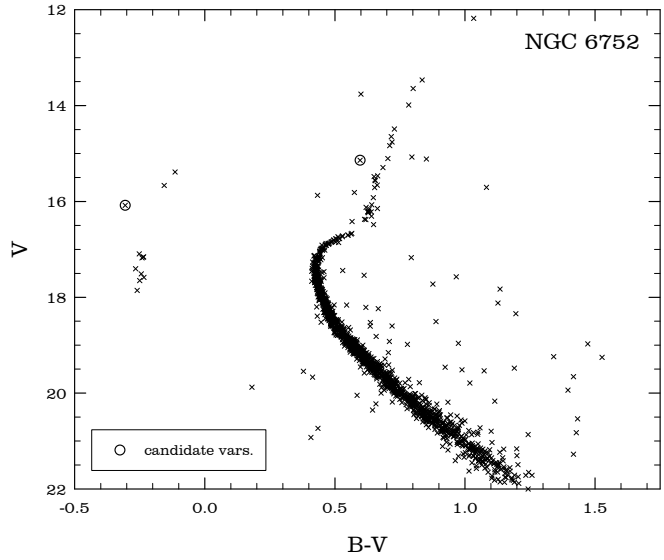

Figure 2. Color-magnitude diagram for our studied MagIC fields. Encircled symbols denote the candidate variables whose light curves are shown in Figure 1.

3. Preliminary Results

3.1. Variable Star Candidates

In Figure 1 we show the first variable star candidates derived on the basis of our MagIC data. The star on the left is V9, which is likely to be a W UMa-type eclipsing binary (Thompson et al. 1999) and does not fall on the HB (see Fig. 2.). The star on the right, on the other hand, is a candidate variable that does fall on the blue extension of the HB. Analysis of the IMACS data should help clarify whether this is a real variable or whether the apparent variation seen in the data is due to systematic errors affecting our photometry.

3.2. Color-Magnitude Diagram

Combining our time-series images using ALLFRAME provides us with a deep color-magnitude diagram (CMD) of unprecedented quality for the cluster (see Fig. 2., again based solely on our MagIC data). There is a remarkable lack of main-sequence (MS) binary stars outside the core of the cluster. This should be compared with a previous result by Rubenstein & Bailyn (1997), who reported on a relatively large (15-38%) MS binary population in the innermost regions of NGC 6752. Such a drop in the binary fraction with radius has recently been predicted in realistic N-body simulations by Hurley, Aarseth, & Shara (2007), according to whom this implies a low *primordial* binary fraction as well. Richer et al. (2007) have recently obtained a similar result for the globular cluster NGC 6397. Such a finding may have important consequences for the formation of EHB stars in globular clusters vs. the field (Catelan 2007).

4. Conclusions and Future Prospects

Our analysis of time-series observations collected with the Magellan 6.5m MagIC camera already reveals a few intriguing variable candidates, including at least one on the hot extension of the HB, in two small fields located away from the cluster center. We have recently acquired extensive time-series observations using IMACS over a much larger field. These data will help confirm the nature of the suspected variables, and will presumably reveal a host of other faint/low-amplitude variables in NGC 6752. In addition, the new data will allow us to map the MS binary fraction in the cluster as a function of radius, which will reveal, for the first time, how in detail the binary fraction decreases as a function of radius in a globular star cluster.

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